Site Need Statement

General Reference Information	
1 *	***Need Title*:** Advanced/Improved Vitrification
2 *	***Need Code:*** RL-WT080
3 *	***Need Summary*:** Current baseline HLW vitrification technology imposes limitations to glass waste loading resulting in increased glass volumes and resultant number of HLW canisters. The current baseline LAW vitrification technology requires very large melters with key components, that require frequent replacement. Both the HLW and LAW melters also create significant solid waste disposal issues due to their size and disposal requirements. Alternative or advanced technologies have not been evaluated to determine their ability to significantly reduce life-cycle production and disposal costs. Concurrent evaluation and demonstration of HLW and LAW glasses that can achieve higher waste loadings or durable crystalline phases also need to be performed. This need includes higher temperature joule heated melters, cold wall or cold crucible melters, and higher waste loading techniques; i.e., dealing with problem constituents. (See J.Ahearne et al., "High-Level Waste Melter Review Report", TFA-0108, July 2001).
4 *	***Origination Date*:** FY 2001 (October 18, 2001)
5 *	***Need Type*:** Technology Need
6	***Operation Office*:** Office of River Protection
7	***Geographic Site Name*:** Hanford Site
8 *	***Project*:** Waste Treatment and Immobilization Plant PBS No: RL-TW06
9	***National Priority:*** ____1. High - Critical to the success of the EM program, and a solution is required to achieve the current planned cost and schedule. _X_2. Medium - Provides substantial benefit to EM program projects (e.g., moderate to high life-cycle cost savings or risk reduction, increased likelihood of compliance, increased assurance to avoid schedule delays). ____3. Low - Provides opportunities for significant, but lower cost savings or risk reduction, may reduce the uncertainty in EM program project success.
10	***Operations Office Priority*:**
Problem Description Information	
11	***Operations Office Program Description*:** To perform the activities necessary to remediate the Hanford tank waste, DOE assigned responsibility to the Office of River Protection (ORP) in Richland, Washington. DOE has extended a contract for the design, construction, and commissioning of a new Waste Treatment and Immobilization Plant (WTP) that will treat and immobilize the waste for ultimate disposal. The WTP is comprised of four major elements, pretreatment, LAW immobilization, HLW immobilization, and balance of plant facilities.
12	***Need/Problem Description*:** Borosilicate glass was selected in 1982 as the preferred waste form for defense high-level waste disposal in the federal geologic repository. In the same time period the joule-heated ceramic melter was selected as the preferred U.S. DOE vitrification technology. The Hanford River Protection Project is proceeding with the design and construction of the Waste Treatment Plant for high-level and low-level waste vitrification. Under the current schedule, it is required that well-defined borosilicate waste forms and joule-heated melter technology designs be selected. Even though the current technology baseline incorporates some improvements, significant increases in waste loading and glass volume reduction are achievable if advanced waste form development and/or alternative technology can be shown to meet the WTP requirements. Specific to Hanford HLW, relatively high levels of iron, aluminum, chrome/nickel, zirconium, and phosphate (to a limited extent) individually or in combination restrict waste loadings in borosilicate glasses melted at 1,150ºC. Exceeding solubility limits for these components results in crystal formation which must be prevented from occurring in the current technology. In a majority of glass compositions, it is this processing constraint that limits glass waste loading and ,therefore, defines the quantity of glass canisters that will be produced. Specific to Hanford LAW, waste constituents that have only limited solubility in the current glass

	formulations will dictate waste loading. These minor constituents include sulfate, chloride, fluoride, chromium and phosphate. Waste loading limitations will define the quantity of ILAW produced. In addition, the number of vitrification units and production and availability requirements could also be affected. Sulfate has the largest possible effect on glass volume production. Due to the high sodium content of the LAW higher-temperature processing is not very practical. In this case, alternative glass and glass/crystalline forms and melters capable of producing them are preferred options. Additional and potentially more important issues with LAW processing are the melter size, high maintenance requirements, and disposal volumes. More compact, high-capacity, reliable technology resulting in minimal solid waste is the optimum solution.
13	***Functional Performance Requirements*:** The alternative technologies need to reduce the overall life-cycle cost for production and disposal of vitrified HLW glasses.
14	***Definition of Solution*:** Acceptable solutions will be achieved for each of the requirements when waste forms have been developed and demonstrated to meet the requirements, and vitrification technologies have been evaluated and demonstrated at glass production scales of about 1 t/d for IHLW and 5 t/d for ILAW.
15 *	***Targeted Focus Area*:** Tanks Focus Area
16	***Potential Benefits*:** Primary technical benefits include increased plant operating performance and a relaxation in waste/waste form composition constraints. Insertion of improved technology prior to Phase 2 operations could avoid the construction of a second LAW vitrification facility and avoidance of operating and contaminating a second IHLW vitrification cell. Operating costs would be reduced through increased on-line efficiency and reduced solid radioactive waste volumes.
17	***Potential Cost Savings*:** A DOE EM-40 study has estimated that life-cycle HLW cost savings of between $1.9B and $4.3B could be achieved by increased waste loading and reduced canister production. LAW vitrification cost savings would include avoidance of ~$520M in capital construction costs for a second facility plus reduced operating and ILAW disposal costs.
18	***Potential Cost Savings Narrative*:** With the WTP annual operating cost expected to be in the hundred's of millions of dollars, minimizing plant start up or down time will be a key potential savings, easily measured in the tens of millions of dollars. Because the cost of disposing a single canister of HLW at the national deep geologic repository is expected to cost several hundred thousand dollars, process improvements that increase waste loading or reduce the amount of non-HLW constituents going into the HLW canister have a significant payback by reducing the number of canisters that must go to the repository. This savings is measured in the hundreds of millions of dollars.
19	***Technical Basis*:** Current baseline technology requires waste forms to be produced with reduced waste loadings as a compromise to the technology. Resolution of this need may increase WTP flexibility and technical and economic performance.
20	***Cultural/Stakeholder Basis*:** The River Protection Project is committed to moving forward to design, construct, and put into operation the Waste Treatment and Immobilization Plant on the schedule recently agreed to in the Tri-Party Agreement. A robust program is necessary to ensure that delays, all of which are costly, are minimized. A key part of this risk mitigation is to include in the total program a capability to test with actual wastes the processes and equipment planned, or later in use.
21	***Environment, Safety, and Health Basis*:** Reduced IHLW and ILAW packages reduce the risks to workers and the environment. Reduced operating periods will reduce worker exposure and a reduced facility life.
22	***Regulatory Drivers*:** Environmental Impact Statement (EIS) for the Tank Waste Remediation System (TWRS) (DOE-RL and Ecology 1996) and the Hanford Federal Facility Agreement and Consent Order (known as the Tri-Party Agreement) and its amendments. DOE has negotiated additions to the Tri-Party Agreement that require the retrieval of single shell tanks by 2018, and the startup and operation of the WTP to support the treatment and immobilization of tank waste. By operating the WTP not only is that capability demonstrated and about 10% by volume (25% by activity) of the tank waste processed, but space is made available in the double shell tanks to allow the single shell tank retrieval to proceed without the expenditure of vast sums for additional double shell tanks. Other regulatory drivers include gathering the data necessary for the regulatory permits required for the startup and operation of the facility.
23	***Milestones*:** November 15, 1999 tri-party agreement on principal regulatory commitments: • Start (Hot) commissioning-Phase I Treatment Complex 12/2007

	• Start Operation-Phase 1 Treatment Complex 12/2009 • Complete Phase I-Treatment (no less than 10% of the tank waste by volume and 25% of the tank waste by activity) 12/2018 Other selected TPA milestones are: • Retrieve all SSTs 2018 • Close SSTs 2024 • Immobilize remaining tank waste 2028 • Close all tanks 2032
24	***Material Streams*:** Hanford High-Level Defense Waste. The River Protection Project (formerly known as the Tank Waste Remediation System) involves PBSs RL TW-01 through TW-09. The technical, work scope definition, and intersite dependency risks for Phase 1 Waste Treatment and Immobilization is respectively, 3,3,3 on a scale of 1 to 5 where "5" represents high programmatic risk. This stream is on the critical closure path for Hanford Site cleanup.
25	***TSD System*:** Hanford Waste Treatment and Immobilization Plant. Technical risk is timely startup of this plant and its ability to operate at planned throughput (capacity and operating efficiency).
26	***Major Contaminants*:** Fission products, actinides, and nitrate.
27	***Contaminated Media*:** Tank waste consisting of supernate (liquid), salt cake, and sludge.
28	***Volume/Size of Contaminated Media*:** The Hanford Site has 177 underground tanks that store 204 million liters (54 M gallons) of waste containing about 190 MCi of activity.
29 *	***Earliest Date Required*:** 11/2002 The earliest date required is in support of WTP permitting.
30 *	***Latest Date Required*:** 10/2007 To support Phase 2 operations a FY 2008 completion date will be required.
Baseline Technology Information	
31	***Baseline Technology/Process*:** The current technology is a joule-heated melter that operates at a nominal temperature of 1,150ºC and employs bubblers to increase production rates. Current technology will produce an estimated 12,200 canisters (14,000 m^3) of IHLW and 72,000 containers (185,000 m^3) of ILAW. Plant operations will be completed between 2028 and 2040. *Technology Insertion Point(s):* N/A
32	***Life-Cycle Cost Using Baseline*:** The current baseline for the WTP is several billion dollars, with the BNI estimate itself is in the $4 billion range. The current River Protection Project life cycle costs are estimated at approximately $50 billion.
33	***Uncertainty on Baseline Life-Cycle Cost*:** There is large uncertainty in the WTP life-cycle cost, providing the opportunity to reduce the life-cycle cost due to operation improvements as well as ensuring operational success not to add additional cost to the system.
34	***Completion Date Using Baseline:***
Points of Contact (POC)	
35	***Contractor End User POCs*:** Paul Rutland, River Protection Project – Waste Treatment Plant, Process Technology Flowsheet, P/509-371-5213; F/509-371-5163; email: plrutlan@bechtel.com Steve Barnes, River Protection Project – Waste Treatment Plant, Research and Technology – Vitrification Technology, P/509-371-5127, F/509-371-5163, email: smbarnes@bechtel.com
36	***DOE End User POCs*:** R. (Rudy) Carreon, DOE Office of River Protection Project Requirements Division, 509-373-7771, F/509-373-0628, email: Rodolfo_Rudy_Carreon@rl.gov B.M. (Billie) Mauss, DOE Office of River Protection Program Office, 509-373-9876, F/509-372-2781, email: Billie_M_Mauss@rl.gov E.J. (Joe) Cruz, DOE Office of River Protection Project Requirements Division, 509-372-2606, F/509-373-1313, email: E_J_Cruz@rl.gov
37 *	***Other Contacts***

*Element of a Site Need Statement appearing in IPABS-IS